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Exploring Racial/Ethnic Disparities in Michigan State Police Traffic Stops Using the Veil of Darkness Methodology

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Travis Carter
Jedidiah Knode
Scott Wolfe

Michigan Justice Statistics Center
School of Criminal Justice
Michigan State University

PREPARED BY THE MICHIGAN JUSTICE STATISTICS CENTER
cj.msu.edu

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Table of Contents

ABOUT THE AUTHORS

Travis Carter is a doctoral student in the School of Criminal Justice at Michigan State University and Graduate Research Fellow in the Michigan Justice Statistics Center. He graduated with a Bachelor of Science in Criminology, Law, and Justice from the University of Iowa in 2019. His current research focuses on the study of crime trends and policing. He was co-author on a report that explored racial/ethnic disparities in Michigan State Police traffic stops during 2020.

Jedidiah Knode is a doctoral student in the School of Criminal Justice at Michigan State University and Graduate Research Fellow in the Michigan Justice Statistics Center. He graduated from Colorado State University in 2020 with a Bachelor of Science in Psychology. His research interests revolve around policing, including community engagement, use of force, and perceived legitimacy. He was co-author on a report that explored racial/ethnic disparities in Michigan State Police traffic stops during 2020.

Scott Wolfe is Associate Director of the School of Criminal Justice at Michigan State University and Director of the Michigan Justice Statistics Center. Dr. Wolfe's research focuses on policing, and he has published on issues including police-community relations, police training, officer safety and wellness, and police employee-supervisor relations. Dr. Wolfe has worked on several projects aimed at addressing racial and ethnic disparities in policing outcomes including as a researcher on the New Orleans Police Department's Consent Decree, the San Francisco Police Department's Collaborative Reform Initiative, and the Phoenix Police Department's analysis of the use of deadly force, and as a training and assessment developer for the Chicago Police Department's Fourth Amendment training program. He was lead author of a report that explored racial/ethnic disparities in Michigan State Police (MSP) traffic stops during 2020, and is Principal Investigator on a Bureau of Justice Statistics grant aimed at evaluating MSP's internal traffic stop data dashboard. Dr. Wolfe holds a Ph.D. in criminology and criminal justice from Arizona State University.

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Web: cj.msu.edu
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Corresponding author email: wolfesc1@msu.edu

EXECUTIVE SUMMARY

This report presents the results from a racial/ethnic disparity analysis of Michigan State Police (MSP) traffic stops conducted in 2021. The goal of the analysis is to identify the extent of racial/ethnic disparities in MSP traffic stop behavior across MSP worksites (i.e., posts). The analyses are based on a leading empirical approach to assessing racial/ethnic disparities in traffic stop behavior—the veil-of-darkness (VOD). The analyses account for important structural differences across posts and their jurisdictions, such as the rate of violent crime and troopers per capita, as well as temporal factors that may shape traffic patterns and stop behavior (e.g., time of day, day of week) to help ensure the results are as informative as possible. Below, we briefly outline the methodology employed and summarize the main findings.

When discussing the results from this report, it is important to recognize the difference between "disparity" and "discrimination." Disparity in these traffic stop analyses refers to differences in racial/ethnic group representation based on presumed visibility of the driver. Disparity cannot identify intent, whereas discrimination inherently involves intent. Therefore, discrimination in traffic stop behavior refers to police officers intentionally stopping individuals based on their status in a racial/ethnic minority group. Discrimination can generate disparities by way of differential treatment of racial/ethnic groups, but disparities may also be the result of non-discriminatory (e.g., environmental, situational, etc.) factors such as crime prevalence and driving pattern differences. This report and its findings can speak only to the extent of racial/ethnic disparity in MSP traffic stops. The data cannot ascertain whether racially discriminatory practices are occurring within MSP. Although disentangling disparity from bias is critical towards improving police practices, accurately identifying the existence of such disparity and its magnitude is an important precursor to this process. More information on the data collection process is provided in the body of the report. Next, we highlight the main takeaways from the analyses.

Veil of Darkness Results:

We used an analytical approach to estimate potential racial/ethnic disparities in MSP traffic stops that is referred to as the "veil-of-darkness" (VOD). The VOD is recognized as a leading approach to estimating racial/ethnic disparities in traffic stops because of its quasi-experimental design and ability to account for external factors that shape patrol and traffic patterns. The VOD works by assuming that police officers have more difficulty discerning the race/ethnicity of a driver based on visual appearance prior to a traffic stop when it is dark outside than when it is light outside. If a larger proportion of traffic stops involving drivers of a racial/ethnic minority group exists in daylight compared to in darkness, this would indicate a disparity in traffic stop behavior due to drivers' racial/ethnic appearance. The VOD restricts its attention to only those traffic stops that occurred during the intertwilight period (i.e., the earliest dusk to the latest sunset). Doing so creates an experimental setting that leverages the seasonal variation in daylight to account for differences in travel patterns across groups of people. In other words, holding all else equal, stops during daylight are compared to similar stops that occurred at the same time of day but during darkness (during a different time of year) for each racial/ethnic group. Holding other factors

constant, any observed differences in the proportion of stops based on drivers' racial/ethnic group makeup may be due to differences in their perceived race/ethnicity. The main VOD results were as follows:

- Traffic stops conducted in daylight were 11% more likely to involve an African-American driver. Daylight stops were also 18% more likely to involve a Hispanic driver than those conducted in periods of darkness. These findings exist even after accounting for other factors that also may predict driver race/ethnicity.

One limitation of these findings is that there could be seasonal variation in traffic flow over the course of the year, which in turn may impact the underlying population at risk of being involved in a traffic stop. Given that VOD analyses assume no seasonal differences in traffic patterns, it could reap inaccurate findings if this assumption is incorrect. One popular solution is to analyze traffic stops conducted 30 days before and after the switch to and from daylight savings time (DST). Accordingly, we re-estimated the VOD analyses while restricting the data to around the switch to and from DST, which led to the following findings:

- After accounting for potential seasonal variation in traffic flow and traffic stop behavior, African-American and Hispanic drivers were *no more likely* to be involved in traffic stops in daylight compared to darkness. Accordingly, when analyzing traffic stops conducted within the ITP and 30 days before and after the switch to and from DST, the results revealed no racial/ethnic disparities. However, the results from this DST-centered re-analysis should be interpreted cautiously given that it is based on a third of the full traffic stop data within the original analysis.

Secure Cities Partnership Veil of Darkness Results:

There are 11 cities in Michigan that participate in the Secure Cities Partnership (SCP). This involves MSP providing patrol support in these cities to assist with crime reduction efforts. Importantly, the racial/ethnic composition of these 11 cities is much different than other areas of the state. It is possible that the inclusion of SCP locations could influence the overall findings from the VOD analyses. Accordingly, we re-estimated two separate VOD analyses after isolating attention to a) only stops that occurred in SCP locations and b) only stops not occurring in SCP locations, respectively. The results were as follows:

- Restricting the VOD analysis to only those stops that occurred in SCP locations while under grant/directed patrol revealed a greater disparity for African-American drivers and no disparity for Hispanic drivers. More specifically, stops during daylight were 60% more likely to involve an African-American driver than stops during periods of darkness within SCP locations. However, daylight stops were no more likely to involve Hispanic drivers than those conducted in darkness within the 11 SCP locations.
- Conducting the VOD analysis after *excluding* traffic stops that occurred in SCP locations as part of a grant/directed patrol initiative yielded similar findings to the main VOD results.

Stops conducted in daylight were 14% more likely to involve African-American drivers and 24% more likely to involve Hispanic drivers than those that occurred in darkness. Thus, removing SCP stops from the analysis does not appear to change the overall results observed at a state level.

Post-by-Post Veil of Darkness Results:

Another caveat to the main findings is that the analyses assumed the effect of daylight on drivers' race/ethnicity (i.e., the disparity) varies randomly across MSP posts. It may be that not all posts exhibit significant racial/ethnic disparity in their traffic stop behavior. Instead, the racial/ethnic disparity may differ both in magnitude and statistical significance across posts. Accordingly, we conducted a post-level analysis whereby each post was examined separately to shed light on the extent of racial/ethnic disparity in traffic stop behavior within posts.

- The results indicate that a small proportion of MSP posts accounted for the racial/ethnic disparities observed statewide. More specifically, daylight stops were more likely to involve African-American drivers compared to stops during darkness in 6 of MSP's posts (i.e., Lansing, Monroe, Tri-City, Flint, Lakeview, and Houghton Lake Post). Conversely, daylight stops were significantly *less likely* to involve African-American drivers compared to stops conducted in in darkness in 1 post (i.e., Grand Rapids). Meanwhile, daylight stops were more likely to involve Hispanic drivers than stops during darkness at 4 of the 30 MSP posts (Monroe, Grand Rapids, Mt. Pleasant, and Cadillac).
- We also conducted post-by-post analyses after excluding SCP-related stops. Note that these results have no bearing on MSP posts that do not have SCP-related traffic stops, rather these analyses reveal what happens to the existing disparity for those posts with SCP traffic stops. Conducting these analyses showed that, again, a small proportion of posts make up the racial disparities observed statewide—even after excluding traffic stops that occurred in SCP locations and were part of a grant/directed patrol initiative. Daylight stops were significantly more likely to involve African-American drivers than traffic stops during periods of darkness in 4 of the 6 posts that were previously identified as having a significant disparity in daylight stops (Monroe, Flint, Lakeview, and Houghton Lake Post). Monroe, Lakeview, and Houghton Lake Post results did not change as there were no SCP-related stops conducted in these posts. However, the disparity remained in the Flint Post even after omitting SCP-related traffic stops. This suggests that in the Lansing and Tri-City Posts, the racial disparity observed in the original post-by-post analysis (see previous bullet point) was constrained entirely to SCP-related traffic stops—but this was not the case in the Flint Post. After omitting the SCP-related stops, Grand Rapids Post troopers were not more or less likely to pull over an African-American driver during the day compared to at night.

INTRODUCTION

In January 2021, the Michigan State Police (MSP) began a partnership with researchers from the School of Criminal Justice (SCJ) at Michigan State University (MSU). The purpose of this partnership was to assess the possible presence of racial/ethnic disparities in MSP traffic stops. To reach this end, MSP began developing and piloted an internal benchmarking dashboard system that allows troopers and supervisors to assess individual traffic stop behavior and make comparisons to others in their worksite. The goal of this dashboard is to provide troopers and command staff with situational awareness regarding their traffic stop data. Moreover, MSP set out to conduct an external benchmark analysis of traffic stop data for 2020. MSU researchers Dr. Scott Wolfe and Dr. Ed McGarrell from the SCJ assisted MSP in this endeavor.

In October 2021, MSP released the findings of the independent external benchmark analysis (see Wolfe, Carter, & Knode, 2021). The overall conclusion of the report was that African-American drivers experienced significant disparities in traffic stops conducted by MSP troopers based on multiple external benchmark analyses. Importantly, these findings highlighted a disparity in traffic stop behavior, but did not speak to the extent of racial/ethnic discrimination in the procedures engaged by troopers when conducting traffic stops. From November 2021 through August 2022, the MSU research partner team consulted with MSP to prepare and conduct a deeper assessment of the extent of racial disparities in MSP traffic stop behavior based on traffic stop data from 2021. This strategy involved using a leading empirical approach to assess whether there was evidence of traffic stop racial/ethnic disparities at the trooper worksite-level (i.e., posts). The current report provides the results of that analysis. Next, we discuss the overall purpose of benchmarking traffic stop data, how it works, and how it is used in this report.

Traffic Stop Benchmarking

When discussing traffic stop benchmarks, it is best to define what purpose these analyses serve and how they work. Benchmarking traffic stop data is conducted with the purpose of examining the presence and extent of racial/ethnic disparities in traffic stop behavior. The primary outcome in benchmarking is racial *disparity*, which is different than racial *discrimination*. Disparity in benchmarking refers to a difference in racial/ethnic group representation between traffic stops and that group's representation in the population. Disparity cannot identify intent, whereas discrimination inherently involves intent. Discrimination may include police officers intentionally treating individuals of a racial/ethnic minority background differently based on their group status. Discrimination can generate disparities by way of differential treatment of racial/ethnic groups, but these same disparities may also be the result of non-discriminatory factors such as crime prevalence and seasonal driving patterns. Accordingly, disparity in and of itself is not sufficient in revealing discrimination. This is why the traffic stop results discussed in this report cannot conclude whether MSP troopers engaged in discriminatory practices when conducting traffic stops. It is important to keep this in mind throughout the report.

Benchmarking works by identifying potential overrepresentation of a particular racial/ethnic group in traffic stops based on their overall representation in another source of data

meant to serve as a proxy measure for the driving population. For example, analysts could compare the racial distribution of traffic stops conducted by MSP in a given county to the racial composition of residents who live in that county (i.e., Census benchmarking). Or, an analyst could compare the racial distribution of traffic stops to traffic collisions. There exist several problems when comparing the racial composition of drivers involved in traffic stops to these other data sources. For example, there are potential differences in the driving population for a given county when compared to that county's residential population. Other potential issues include differences in the risk of being involved in a traffic stop based on time of day and seasonal differences in driving patterns. Census benchmarking is incapable of accounting for these issues and can produce misleading results. These problems have led to innovations in assessing racial disparity.

Veil of Darkness Strategy

The Veil of Darkness (VOD) analysis represents a leading empirical approach to assessing the presence and extent of racial/ethnic disparities in traffic stop data (see the suggested reading list at the end of this report). Grogger and Ridgeway (2006) developed the VOD as a strategy for analyzing disparities in traffic stop behavior by operating on one principal assumption: police officers are less likely to be able to identify the race/ethnicity of a driver when it is dark outside compared to when it is light outside. Rather than applying a traditional benchmarking approach to assessing racial composition of a population across separate sets of data, the VOD works by analyzing traffic stop data over the course of the year since daylight naturally varies. For example, a stop at 7 PM in February takes place during darkness whereas a stop at 7 PM in June takes place during daylight. Identifying potential disparity in traffic stops is, therefore, based on whether drivers of a particular race/ethnicity are pulled over more so during daylight than during darkness. If traffic stops conducted during daylight are more likely to involve drivers of a specific racial/ethnic background than stops at night, this suggests the disparity may be due to visible characteristics such as the driver's race.

Given the simplicity of the primary assumption guiding a VOD analysis, researchers must carefully consider how to account for the reality of day-to-day traffic behavior. Simply comparing the racial/ethnic composition of drivers stopped in daylight and darkness would generate misleading conclusions if the racial/ethnic composition of drivers on the road differs by time of day. Accordingly, one must restrict the VOD analysis to traffic stops occurring within the intertwilight period (ITP), which is the time between earliest onset of darkness and the latest onset of darkness over the course of the year. To put this into perspective, assume the earliest onset of darkness during the year in Michigan is roughly 5 PM—in December—and the latest onset of darkness is around 10 PM—in July. Stops within this window of time throughout the year are included in the ITP and would have either occurred during daylight or darkness (note that there are other restrictions we discuss later). The intuition behind restricting a VOD analysis to stops only occurring within the ITP is that it creates a natural experiment whereby all stops have direct counterfactuals (i.e., comparison groups). It does this by allowing researchers to determine whether daylight stops are more likely to involve racial/ethnic minority group drivers compared to stops at darkness during the same clock time of day throughout the year. Researchers can

additionally account for several other environmental and situational factors that may affect driving patterns and stop behavior to further enhance the validity of the VOD analysis.

MSP TRAFFIC STOPS

This report evaluates traffic stops conducted by MSP troopers across the state of Michigan in 2021. The purpose of this report is to conduct a deeper dive into the presence and extent of racial/ethnic disparities in traffic stops performed by MSP. We facilitate this process by conducting a VOD analysis at the worksite-level (i.e., post). We also attempt to account for a multitude of other relevant factors that may alter both driving patterns and officers' stop behavior to further enhance the validity of the analysis. As stressed earlier, the analysis cannot identify racial *discrimination*, rather the analysis is directed solely at determining whether there are racial *disparities* in traffic stops conducted by MSP. We now turn attention to describing the data and analytic strategy.

Traffic Stop Data

MSP provided the research team with traffic stop data from January 1st to December 31st, 2021. These data reflect all traffic stops conducted by MSP troopers, which are tracked electronically through daily activity logs while on duty. These data include information on the stop incident (i.e., reason for stop, location, time), driver demographics (e.g., race and sex), and patrol information (e.g., trooper assignment).[1]

The original data provided by MSP were organized by offense and thus best described as offense-level data (N = 278,184). In other words, multiple rows/observations may pertain to the same traffic stop incident with multiple outcomes/offenses and/or vehicles per stop. To analyze the data at the stop level, we consolidated observations so that each row uniquely identified a traffic stop incident. In so doing, we constrained the analysis to single-vehicle stops and, thereby, omitted 4.7% of all stops from the original dataset that had duplicated incidents stemming from one traffic stop with multiple offenses, arrests, and/or searches that resulted from the stop (N = 11,912), and incidents that involved multiple vehicles (N = 1,190). This resulted in a total of 265,082 traffic stops in the database. The stop total was reduced further by 3.9% after removing:

- stops where MSP troopers could not identify or did not report the drivers' race (N = 8,764),
- cases where non-traditional traffic stops were conducted by Capitol Security personnel (N = 32), and
- stops involving Marine Services (N = 1,636).

This yielded a total of 254,650 traffic stops included in the database.

[1] Trooper demographic information (i.e., race, sex) was not included in the data provided to the MSU research team. MSP decided not to release this information to the research team. Failing to account for trooper demographic information hinders the racial disparity analyses in this report because some prior studies have shown that police officer race/ethnicity can influence traffic stop decision making (Brown & Frank, 2006; Smith et al., 2021). Accordingly, trooper race/ethnicity may partially predict driver race, but we are not able to account for this possibility.

Location Coding

Analyses conducted in this report are at the post level. The traffic stop database contains fields for the "district," "worksite" (i.e., post), and "county" of each traffic stop. While each post is assigned between two and five counties, a nontrivial number of stops were listed as occurring in a post different than the one it was assigned based on the county it was conducted in (N = 31,476). For example, Bay County falls under Tri-City Post's patrol area. Most stops conducted in Bay County were listed as Tri-City Post stops. However, 58 stops were listed as occurring in Caro Post despite being physically conducted in Bay County. Another 36 stops in Bay County were listed as Lapeer Post stops. The problem is that no two posts are assigned the same county. This suggests that a Lapeer Post trooper conducted a traffic stop in Bay County—Tri-City Post's assigned county. This should come as no surprise given that both Tri-City and Lapeer posts share operational boundaries. Nevertheless, this also suggests that those stops conducted by Caro and Lapeer Post troopers should not be counted towards Tri-City Post. Accordingly, we omitted all "mismatching" stops where troopers conducted a traffic stop outside of their typical patrol boundary. This ensured that we correctly aggregated the stop information up to the post level where the stop was correctly assigned to. This also ensured all post-level characteristics that are controlled for in the analysis were correctly tied to the area of the stop. Omitting these mismatched stops reduced the number of traffic stops in our database by 12.4% (N = 31,476).[2] Accordingly, we were left with 223,173 traffic stops conducted by MSP troopers in 2021.[3]

Driver Race and Ethnicity Coding

The primary outcome in the analyses was the race/ethnicity of the driver involved in a traffic stop. This was obtained from MSP troopers' visual assessment during traffic stops. For context, troopers are not allowed to ask drivers to self-report their race, nor does the state of Michigan include race/ethnicity information on drivers' licenses at this time. Accordingly, visual assessments of drivers' race/ethnicity are part of troopers' reporting obligation when conducting traffic stops and are enforced through MSP policy and training. When a trooper visually assesses a driver's race/ethnicity, they are required to list if the driver is "White," "Black/African American," "Hispanic/Latino," "Asian," "American Indian or Alaskan Native," "Native Hawaiian or Other Pacific Islander," or "Unknown."

[2] It is important to note, that about 48% of the mismatched stops were designated as "Hometown Security Assignment" in the database. This is an assignment that involves troopers on the Hometown Security Team (HST) engaging in focused enforcement in areas of need. Accordingly, these troopers often conduct stops in locations that are, technically, outside their normal Post. Within the veil of darkness (VOD) analyses below, HST stops represent about 29.8% of the mismatched stops that are excluded from the analyses (N = 1,041 stops). We conducted supplemental analyses to determine whether excluding mismatched stops influenced the findings. For the main analysis reported in Table 4 and the post-by-post analyses in Table 8, all results remained substantively unchanged (i.e., the magnitude of effects and statistical significance levels were the same). Accordingly, we can be confident that excluding mismatched stops from our analyses did not influence the findings we report. It may be useful to use GPS location data in future analyses to examine the characteristics and outcomes of HST-specific stops.

[3] One additional stop was omitted from the dataset because it lacked any county designation and thus could not be corrected based on its location of occurrence.

As mentioned previously, we omitted the 8,764 stops where the driver's race was listed as "Unknown" by MSP troopers. For the analysis, we recoded driver race into a series of binary variables for each race/ethnicity (*White*, *Black*, *Hispanic*, *Asian*, and *Other*). Drivers who were identified by troopers as American Indians, Alaskan Natives, Native Hawaiians, and Other Pacific Islanders were grouped into the "Other" category due to their infrequency. Although we refer to these categories as driver race/ethnicity, it is important to acknowledge that Hispanic/Latino is an ethnicity despite being compared with other racial groups. We code these data in this manner because current MSP reporting practices and policy opt to include race and ethnicity in a single data field.

Traffic Stops Characteristics

Table 1 presents the distribution of traffic stops conducted by MSP troopers across drivers' race/ethnicity, gender, and trooper assignment. Most stops conducted in 2021 involved a White driver (74.2%) or an African American driver (22.6%). Hispanic drivers made up 2.2% of the 2021 traffic stops, whereas the remaining 1% of stops involved Asian drivers or drivers of another race/ethnicity. The gender distribution of drivers who were stopped was predominantly Male (66.6%) and less than 1% of stops did not indicate the gender of the driver. The breakdown of traffic stops by assignment revealed that the majority were conducted by troopers assigned to "general" patrol activities (67.5%). Almost 20% of stops were conducted by troopers assigned to

Table 1. 2021 MSP traffic strop data descriptive statistics (223,173)

	Number of Stops	Percent
Driver Race/Ethnicity		
White	165,651	74.2%
African American	50,444	22.6%
Hispanic	4,972	2.2%
Asian	1,257	0.6%
Other	849	0.4%
Driver Gender		
Male	148,628	66.6%
Female	74,439	33.4%
Missing	106	0.05%
Trooper Assignment		
General	150,603	67.5%
Grant/directed patrol	44,242	19.8%
Field Training program	13,902	6.2%
Sergeant's duties	9,583	4.3%
Other assignment	4,807	2.2%
Hometown Security Assignment	36	0.01%

Note: Percentages may not sum to 100 due to rounding.

"grant/directed patrol" assignments. The remaining stops were conducted by troopers who were assigned to "Field Training" (6.2%), "Sergeant's duties" (4.3%), other assignments (2.2%), and "Hometown Security" (0.01%).

Table 2 provides the distribution of traffic stops by driver race/ethnicity across MSP posts (i.e., worksites). This is part of a deeper assessment given the potential variation in traffic patterns and stop behavior across posts. Most traffic stops conducted by MSP troopers in each post involved White drivers. This is particularly noticeable across posts in Districts 6, 7, and 8, where their respective populations are predominantly White. However, there were specific posts that diverged from this general pattern, and thereby exemplified the need for post-level analyses. For example, 34.4% of all stops conducted in District 3 involved a Black driver and 63.5% involved a White driver. Yet, MSP troopers in the Flint Post conducted a larger proportion of stops involving Black drivers (57.1%) and a smaller fraction of stops with White drivers (41.6%) compared to the district itself. On a related note, Black and White drivers shared similar distributions among traffic stops in District 2. Yet, each post within District 2 exhibited a distinct racial/ethnic distribution of their respective traffic stops. For example, Metro-North Post differed from District 2 as a whole in that White drivers (60.6%) comprised a larger proportion of stops and Black drivers (36.6%) made up a smaller fraction of stops in this post. In contrast, Metro-South conducted more traffic stops involving Black Drivers (65.2%) and fewer involving White drivers (31.8%) than District 2. This is not necessarily surprising given the demographic characteristics of those patrol areas.

Similar patterns emerged when examining the distribution of Hispanic and Asian drivers stopped by post. Hispanic drivers made up roughly 1 to 5% of all stops conducted in each district, whereas Asian drivers made up about 1% of all stops. However, not all posts have the same underlying populations and, unsurprisingly, have greater Hispanic and Asian representation in their traffic stop race/ethnicity distributions. For example, Hispanic drivers make up 3.7% of all stops conducted in District 6, yet 5.4% of all stops conducted in the Grand Rapids Post involved Hispanic drivers. Similarly, Asian drivers comprised almost 1% of all stops in District 1, yet 1.9% of all stops conducted in Brighton Post. Our analyses must focus on post-level differences because of these observed variations. If no differences existed, we could simply conduct a VOD analysis for the entire state and ignore patterns at individual posts.

VEIL OF DARKNESS ANLAYSIS

Veil of Darkness Design

We rely on a leading strategy for assessing racial disparities in traffic stop data, the VOD method, to facilitate a deeper dive into the extent of racial disparity in MSP traffic stop behavior. In doing so, we conducted the VOD analysis at the MSP post level rather than the district level to account for variation in traffic patterns and stop behavior. In preparation for the analysis, we only examined traffic stops that occurred during each county's ITP to ensure that all stops that occurred during daylight had a comparison set of stops that occurred during darkness. Recall that the ITP is the period between earliest onset of darkness and latest onset of darkness. Accordingly, all stops that occurred during clock times that fall before sunset were coded as "daylight" stops, whereas

Table 2. Racial/ethnic composition of traffic stops across MSP posts in 2021

		White		African American		Hispanic		Asian		Other		Total
		N	%	N	%	N	%	N	%	N	%	N
District	**Post**											
District 1	11-Lansing Post	6,754	70.8%	2,316	24.3%	331	3.5%	97	1.0%	36	0.4%	9,534
	12-Brighton Post	5,351	72.6%	1,712	23.2%	154	2.1%	138	1.9%	15	0.2%	7,370
	13-Jackson Post	6,267	85.2%	948	12.9%	109	1.5%	30	0.4%	5	0.1%	7,359
	14-Monroe Post	5,325	84.0%	795	12.5%	200	3.2%	17	0.3%	1	0.0%	6,338
Total		23,697	77.4%	5,771	18.9%	794	2.6%	282	0.9%	57	0.2%	30,601
District 2	21-Metro North Post	11,180	60.6%	6,755	36.6%	271	1.5%	186	1.0%	55	0.3%	18,447
	22-Metro South Post	4,535	31.8%	9,300	65.2%	291	2.0%	85	0.6%	49	0.3%	14,260
Total		15,715	48.0%	16,055	49.1%	562	1.7%	271	0.8%	104	0.3%	32,707
District 3	31-Tri-City Post	7,027	47.9%	7,028	48.0%	555	3.8%	26	0.2%	20	0.1%	14,656
	32-West Branch Post	3,651	96.6%	93	2.5%	24	0.6%	11	0.3%	0	0.0%	3,779
	33-Caro Post	5,776	96.3%	153	2.6%	58	1.0%	9	0.2%	0	0.0%	5,996
	34-Lapeer Post	9,553	92.2%	627	6.0%	152	1.5%	26	0.3%	6	0.1%	10,364
	35-Flint Post	7,430	41.6%	10,183	57.1%	193	1.1%	25	0.1%	15	0.1%	17,846
Total		33,437	63.5%	18,084	34.4%	982	1.9%	97	0.2%	41	0.1%	52,641
District 5	51-Paw Paw Post	3,625	70.6%	1,221	23.8%	249	4.8%	35	0.7%	8	0.2%	5,138
	52-Wayland Post	3,713	83.5%	460	10.3%	230	5.2%	33	0.7%	10	0.2%	4,446
	53-Niles Post	4,837	55.7%	3,397	39.1%	383	4.4%	59	0.7%	13	0.1%	8,689
	54-Marshall Post	6,189	79.0%	1,170	14.9%	388	5.0%	61	0.8%	27	0.3%	7,835
Total		18,364	70.3%	6,248	23.9%	1,250	4.8%	188	0.7%	58	0.2%	26,108
District 6	61-Grand Rapids Post	7,185	67.8%	2,730	25.8%	573	5.4%	88	0.8%	22	0.2%	10,598
	62-Hart Post	3,304	92.7%	112	3.1%	143	4.0%	6	0.2%	1	0.0%	3,566
	63-Mt. Pleasant Post	4,611	94.1%	190	3.9%	53	1.1%	26	0.5%	19	0.4%	4,899
	64-Lakeview Post	5,603	92.1%	306	5.0%	150	2.5%	18	0.3%	8	0.1%	6,085
Total		20,703	82.3%	3,338	13.3%	919	3.7%	138	0.5%	50	0.2%	25,148
District 7	71-Cadillac Post	8,826	96.4%	152	1.7%	118	1.3%	34	0.4%	21	0.2%	9,151
	72-Houghton Lake Post	7,469	95.8%	191	2.4%	73	0.9%	48	0.6%	18	0.2%	7,799
	73-Gaylord Post	9,202	96.7%	169	1.8%	63	0.7%	37	0.4%	47	0.5%	9,518
	74-Alpena Post	5,165	98.0%	62	1.2%	35	0.7%	9	0.2%	2	0.0%	5,273
Total		30,662	96.6%	574	1.8%	289	0.9%	128	0.4%	88	0.3%	31,741
District 8	81-Negaunee Post	4,274	96.3%	75	1.7%	30	0.7%	36	0.8%	22	0.5%	4,437
	82-Sault Ste. Marie Post	2,613	93.9%	36	1.3%	0	0.0%	16	0.6%	117	4.2%	2,782
	83-St. Ignace Post	3,316	94.9%	86	2.5%	35	1.0%	13	0.4%	45	1.3%	3,495
	84-Gladstone Post	3,507	94.2%	73	2.0%	49	1.3%	15	0.4%	79	2.1%	3,723
	85-Iron Mountain Post	3,854	97.2%	30	0.8%	31	0.8%	19	0.5%	29	0.7%	3,963
	86-Wakefield post	2,415	96.0%	33	1.3%	12	0.5%	23	0.9%	32	1.3%	2,515
	87-Calumet Post	3,094	93.4%	41	1.2%	19	0.6%	31	0.9%	127	3.8%	3,312
Total		23,073	95.2%	374	1.5%	176	0.7%	153	0.6%	451	1.9%	24,227

Note: Row percentages may not sum to 100 due to rounding.

all stops that occurred during clock times after the end of civil twilight (dusk) were coded as "darkness" stops. Additionally, we omitted stops that occurred during the roughly 30-minute period between sunset and dusk, given that these stops could not be reliably coded as occurring in either daylight or darkness (Grogger & Ridgeway, 2006).

The method required us to calculate sunset and dusk times for each county in Michigan. Sun times were calculated utilizing the *suncalc* package for RStudio (github.com/datastorm-open/suncalc). The statistical package derives times based on the position of the sun and Earth (www.aa.quae.nl/en/reken/zonpositie.html). We used this information along with the latitude and longitude of the center of each Michigan county to derive county-specific sunset and dusk times. Time zones were set as EST, with the exception of four counties (Dickinson, Gogebic, Iron, and Menominee), which were set as CST. Accordingly, the earliest dusk and latest sunset times varied by county but ranged from 4:42 PM to 10:37 PM. Constraining the analysis to county-specific ITPs yielded a total of 48,602 traffic stops included in the VOD analysis.

Measures

In conducting the VOD analysis, we constructed a set of multilevel models that were estimated using logistic regression to determine whether daylight predicts the race/ethnicity of a driver in a traffic stop. The outcome of our analysis was driver *race/ethnicity*, and the main explanatory variable was *daylight*. We additionally controlled for stop-level characteristics and post-level factors to ensure that our results were robust to potential variation in these data. Stop-level factors included trooper *assignment type* and the *level of discretion* used when conducting the stop. Level of discretion was dummy coded (high, low, uncertain), with low discretion being omitted as the reference category. It is important to acknowledge that the discretion variable comes from a broader field in the traffic stop database (i.e., *reason for stop*). The original reason for stop field contained too many mutually exclusive values to include in our analyses. Accordingly, the research team developed a preliminary set of codes to define the level of discretion used when conducting a traffic stop. These codes were then cross validated with MSP command staff.[4] We also controlled for the *gender* of the driver during each stop (Male = 1, Female = 0).

Post-level factors included *violent crime rate* and number of *troopers per capita*. Violent crime rates and trooper rates were constructed by dividing the number of violent crimes (i.e., murder, forcible rape, robbery, and assault) and troopers per post by the overall population that each post had jurisdiction over in 2020, and then multiplying that by 100,000 residents, respectively.

[4] It is important to note that the discretion variable contains an "uncertain" category. MSP command staff acknowledged that the original reason for stop codes may be capturing post-stop outcomes in some situations. For example, one reason for stop that was listed was "8050-OPERATING WHILE UNDER 21 W/BAC." Drivers may be pulled over based on a traffic violation (e.g., failure to signal a lane change), but the reason listed here is what troopers discovered after the stop occurred. This could be due in part to the process by which troopers record their UD-2s and also how the data is generated in the Records Management System. Accordingly, all stops where the reason for stop could not be reasonably defined as a reason prior to the stop were coded as "uncertain" discretion.

We also accounted for temporal patterns in traffic flow and traffic stop behavior by controlling for *day of week* and *time of day*. Day of week was measured through a series of dummy variables indicating what day a stop was conducted with Sunday being omitted as the reference category. Time of day was an interval variable that indicated when a stop took place according to a time bin, which was created by dividing the ITP into 45-minute intervals. In doing so, we separated the ITP into 8 equal intervals with the earliest interval (from the earliest dusk to 45-minutes later) coded as 1, the second 45-minute interval coded as 2, and so on.

Summary Statistics

The distribution of traffic stops by driver race/ethnicity is presented in Table 3. The first column shows the proportion of stops for each racial/ethnic group within the ITP. In general, White drivers made up the largest proportion of stops conducted by MSP troopers during the ITP (75.4%). African-American drivers made up 21.5% of stops during the ITP, and about 3% of stops involved drivers identified as Hispanic, Asian, or another race/ethnicity. The daylight and darkness columns for the ITP present the proportion of stops within each racial/ethnic group. In general, a larger proportion of stops within the ITP were conducted in daylight than in darkness. This holds true within each racial/ethnic group as well. For example, more than half of all stops conducted in the ITP for White drivers occurred in daylight (55.6%) and less than half occurred in darkness (44.6%). A similar pattern emerged for African-American drivers as well (Daylight = 54.5%, Darkness = 45.5%).

Table 3. Veil of Darkness descriptive statistics

	ITP [a]		Daylight ITP [b]		Darkness ITP [b]	
	N	%	N	%	N	%
Driver Race/Ethnicity						
White	36,639	75.4%	20,370	55.6%	16,269	44.6%
African American	10,439	21.5%	5,692	54.5%	4,747	45.5%
Hispanic	1,040	2.1%	599	57.6%	441	42.4%
Asian	294	0.6%	183	62.2%	111	37.8%
Other	190	0.4%	102	53.7%	88	46.3%
Total	48,602		26,946	55.4%	21,656	44.6%

Note: [a] Indicates column percentage. [b] Indicates row percentage. ITP = Intertwilight period. Percentages may not sum to 100 due to rounding

Results

Veil of Darkness Analysis

Tables 4 and 5 present the results from our main VOD analyses, whereby we used logistic regression equations to estimate the effect that daylight has on the race/ethnicity of drivers involved in traffic stops.[5] In Table 4, the results reveal that daylight traffic stops were 11% more

[5] Prior to estimating the final models, we examined whether the effect that daylight has on driver race/ethnicity varied across posts. A nested model test was conducted between a random-slope and random-intercept model, which

likely to involve African-American drivers than stops conducted in darkness (OR = 1.11, $p \leq .05$, 95% CI [1.00,1.23]). This suggests that daylight stops were more likely to involve African-American drivers when, presumably, it is easier to see drivers' race. This association holds even after accounting for temporal variation in traffic behavior, post-level variation in crime rate and trooper workforce size, discretion level of the stop, and patrol assignment type. For example, stops conducted as part of a grant or directed patrol activity were more likely to involve an African-American driver when compared to stops that fell under general patrol activity (OR = 3.26, $p \leq .01$, 95% CI [2.09, 5.08]). Similarly, traffic stops involving male drivers were 21% more likely to be African-American than stops involving female drivers (OR = 1.21, $p \leq .01$, 95% CI [1.07, 1.38]).

Table 4. Multilevel Veil of Darkness logistic regression predicting driver race/ethnicity: African American and Hispanic

	Driver Race/Ethnicity							
	African American (N = 10,439)				Hispanic (N = 1,040)			
			95% CIs				95% CIs	
	OR	SE	LL	UL	OR	SE	LL	UL
Fixed Effects								
Stop-Level Variables								
Intercept	0.01**	0.01	0.00	0.04	0.01**	0.01	0.00	0.03
Daylight	1.11*	0.06	1.00	1.23	1.18*	0.09	1.01	1.37
Assignment Type [a]								
Grant/directed patrol	3.26**	0.74	2.09	5.08	0.82	0.15	0.57	1.17
Field Training program	0.88	0.13	0.67	1.16	1.02	0.20	0.69	1.50
Sergeant's duties	1.53*	0.33	1.01	2.34	0.83	0.18	0.54	1.26
Other assignment	1.04	0.16	0.77	1.39	1.01	0.29	0.57	1.79
Hometown Assignment	-	-	-	-	-	-	-	-
Discretion Level [b]								
High Discretion	1.08	0.11	0.89	1.30	0.86*	0.06	0.76	0.98
Uncertain	1.97**	0.23	1.56	2.49	0.90	0.20	0.58	1.39
Day of Week [c]								
Monday	0.85**	0.04	0.78	0.94	1.10	0.10	0.92	1.31
Tuesday	0.94	0.07	0.80	1.10	0.95	0.13	0.72	1.24
Wednesday	1.04	0.09	0.88	1.22	0.75*	0.08	0.61	0.93
Thursday	0.94	0.08	0.79	1.11	0.93	0.07	0.80	1.09
Friday	0.93	0.08	0.80	1.09	0.78*	0.08	0.63	0.96
Saturday	1.03	0.06	0.93	1.15	0.90	0.09	0.75	1.09
Time of Day	1.08**	0.02	1.04	1.13		0.02	0.99	1.05
Male	1.21**	0.08	1.07	1.38	2.13**	0.21	1.77	2.60
Post-Level Variables								
Violent Crime Rate	1.00**	≤0.01	1.00	1.01	1.00	≤0.01	1.00	1.00
Troopers Per Capita	0.81	0.13	0.59	1.10	0.84*	0.22	0.73	0.99
Random Effects								
Post-Level Variance (τ^2_0)	1.03	0.24	0.65	1.63	0.47	0.11	0.30	0.75
Daylight Variance (τ^2_1)	0.07	0.02	0.03	0.13	-	-	-	-
Deviance	33,827.85				9,456.46			

Note: OR indicate odds ratios. Robust errors reported for stop-level variables. [a] Reference assignment type is General patrol. [b] Reference discretion level is Low Discretion. [c] Reference day of week is Sunday. † $p \leq 0.10$, * $p \leq .05$, ** $p \leq .01$

indicated that the daylight variable effect varied significantly across posts for Black drivers ($\chi 2[1] = 72.32$, $p < .001$) but not Hispanic, Asian, and Other drivers.

Table 4 also demonstrates that daylight stops were 18% more likely to involve a Hispanic driver than stops conducted in darkness (OR = 1.18, $p \leq .05$, 95% CI [1.01,1.37]). Several other variables were significantly associated with the odds of a traffic stop involving a Hispanic driver as well. For example, stops involving high levels of discretion were significantly less likely to involve a driver that was Hispanic when compared to stops involving low discretion (OR = 0.86, $p \leq .05$, 95% CI [0.76,0.98]). Traffic stops involving male drivers were twice as likely to be Hispanic (OR = 2.13, $p \leq .01$, 95% CI [1.77,2.60).

Table 5 presents the results of the VOD analyses when examining stops involving Asian drivers and drivers of other races/ethnicities. Neither of these models indicated that daylight was significantly associated with stops involving Asian or Other drivers. In other words, Asian drivers and Other drivers were equally likely to be pulled over during daylight as they were during darkness, despite the potential difference in visibility between these periods. Results also indicated that Asian drivers were significantly less likely to be involved in traffic stops involving

Table 5. Multilevel Veil of Darkness logistic regression predicting driver race/ethnicity: Asian and Other

	Driver Race/Ethnicity							
	Asian (N = 294)				Other (N = 190)			
			95% CIs				95% CIs	
	OR	SE	LL	UL	OR	SE	LL	UL
Fixed Effects								
Stop-Level Variables								
Intercept	0.01**	≤0.01	0.01	0.02	0.00**	≤0.01	0.00	0.00
Daylight	1.32	0.23	0.94	1.86	1.16	0.17	0.87	1.54
Assignment Type [a]								
Grant/directed patrol	0.81	0.13	0.59	1.13	0.64†	0.17	0.38	1.07
Field Training program	0.79	0.26	0.41	1.51	1.16	0.48	0.52	2.59
Sergeant's duties	0.98	0.39	0.44	2.16	1.82	1.08	0.57	5.83
Other assignment	1.77†	0.54	0.98	3.21	-	-	-	-
Hometown Assignment	-	-	-	-	-	-	-	-
Discretion Level [b]								
High Discretion	0.42**	0.06	0.32	0.57	0.95	0.26	0.56	1.63
Uncertain	0.06**	0.07	0.01	0.49	1.42	0.74	0.51	3.92
Day of Week [c]								
Monday	0.88	0.20	0.56	1.36	0.79	0.21	0.47	1.33
Tuesday	0.68	0.19	0.39	1.17	1.21	0.46	0.57	2.54
Wednesday	0.47**	0.12	0.28	0.79	1.00	0.33	0.52	1.90
Thursday	0.62	0.20	0.33	1.17	1.29	0.37	0.73	2.28
Friday	0.66*	0.13	0.45	0.96	0.90	0.33	0.44	1.84
Saturday	0.63*	0.14	0.40	0.98	1.10	0.39	0.55	2.21
Time of Day	1.03	0.03	0.97	1.09	1.08*	0.04	1.00	1.17
Male	1.00	0.12	0.78	1.27	1.04	0.18	0.75	1.45
Post-Level Variables								
Violent Crime Rate	1.00	≤0.01	1.00	1.00	1.00	≤0.01	1.00	1.00
Troopers Per Capita	1.00	0.05	0.91	1.10	1.19†	0.12	0.97	1.46
Random Effects								
Post-Level Variance (τ^2_0)	0.41	0.20	0.16	1.04	1.73	0.69	0.79	3.78
Daylight Variance (τ^2_1)	0.14	0.09	0.04	0.48				
Deviance	3,420.60				2,196.47			

Note: OR indicate odds ratios. Robust errors reported for stop-level variables. [a] Reference assignment type is General patrol. [b] Reference discretion level is Low Discretion. [c] Reference day of week is Sunday. † $p \leq 0.10$, * $p \leq .05$, ** $p \leq .01$

high-discretion (OR = 0.42, $p \leq .01$, 95% CI [0.32,0.57]) and uncertain levels of discretion (OR = 0.06, $p \leq .01$, 95% CI [0.01,0.49]) when compared to stops involving low levels of discretion.

Veil of Darkness Analysis with Seasonality Adjustment

One potential limitation to the VOD analysis is that driving patterns may change throughout the course of a year. Failing to account for differences in the underlying population at risk to being pulled over during different parts of the year may lead to inaccurate conclusions. One commonly employed solution to account for seasonality in traffic flow is to analyze data around daylight savings time (DST). Restricting a VOD analysis to the 30-days before and after the switch to and from the DST allows researchers to analyze a difference in daylight at the same time of day while concomitantly controlling for variation in driving patterns over the course of a year (Stacey & Bonner, 2021; Taniguchi et al., 2017). We therefore restricted the VOD analysis to traffic stop data within the ITP that occurred during the 30-days before and after the switch to and from DST which began on March 14, 2021, and ended on November 7, 2021. Approximately 7,955 traffic stops were conducted by MSP between February 12—April 13, 2021, which spans the 30 days before and after DST began (including the day of). Another 6,956 traffic stops were conducted by MSP between October 8—December 7, 2021, which were the 30 days before and after DST ended (including the day of). In total, we restricted our analysis to 14,911 traffic stops within the ITP to account for potential seasonality in the data. The results for these analyses are presented in Table A1 in the appendix.[6]

In general, these results show that once we restricted the analysis based on DST, daylight no longer predicted the odds of a driver being African American or Hispanic in a traffic stop. In other words, African-American and Hispanic drivers were no more likely to be pulled over in daylight than in darkness when constraining the analysis to the 30 days before and after the switch to and from DST. This finding suggests that when we constrain the analysis to a time span when traffic flow patterns remain similar there were no racial/ethnic disparities in MSP traffic stop behavior. However, the results from this DST-centered re-analysis should be interpreted cautiously. For one, some scholars criticize the DST restriction because of the extent to which it limits the scope of data availability (Ritter, 2009). In this case, we analyzed roughly a third of the full ITP data. In addition, the DST restriction may lack relevance in the future if the United States no longer uses the DST shift per the Sunshine Protection Act of 2021.

Secure Cities Partnership Analyses

Next, we examined all traffic stops conducted by MSP troopers in 2021 that occurred in cities that fall under the Secure Cities Partnership (SCP). The SCP involves a joint effort between 11 Michigan cities and MSP to reduce violent crime through the deployment of additional patrol support. These cities include Benton Harbor, Detroit, Flint, Hamtramck, Harper Woods, Highland Park, Inkster, Lansing, Muskegon Heights, Pontiac, and Saginaw. We restricted the analysis to these cities in part because of their high-crime prevalence, which may partly contribute to different patrol

[6] We restricted these analyses to only African-American and Hispanic drivers given the disparities discovered in the prior analyses.

deployment activities for each city's population and, consequently, influence the racial/ethnic disparity findings reported earlier.

In conducting the SCP-focused VOD analysis, we restricted attention to stops conducted by troopers assigned to grant/directed patrol duties. This isolated the analysis to only those traffic stops that occurred in a SCP location and were related to grant/directed patrol activities. Table 6 provides descriptive statistics for all traffic stops that occurred in 2021 within SCP locations while also falling within grant/directed patrol assignments. Results from this table reveal a stark difference in the racial/ethnic distribution of traffic stops when compared to all other stops across the state of Michigan. Almost 82% of all stops in SCP locations involved African-American drivers, which is notably larger than the proportion of African-American drivers pulled over statewide (22.6%). This difference is due in part to underlying differences in the overall demographic makeup of residents in SCP locations compared to the state. A majority of stops conducted in SCP locations occurred in the city of Flint (30.6%) and Saginaw (26.9%).

Table 6. 2021 MSP traffic strop data descriptive statistics for Secure Cities Partnership Locations (N = 5,163)

	Number of Stops	Percent
Driver Race/Ethnicity		
African American	4,219	81.7%
White	837	16.2%
Hispanic	97	1.9%
Asian	8	0.1%
Other	2	0.04%
Driver Gender		
Male	3,808	73.8%
Female	1,354	26.2%
Missing	1	0.02%
MSP Secure Cities Partnership Location		
Flint	1,580	30.6%
Saginaw	1,387	26.9%
Benton Harbor	735	14.2%
Muskegon Heights	505	9.8%
Inkster	446	8.6%
Lansing	276	5.4%
Detroit	207	4.0%
Highland Park	25	0.5%
Harper Woods	2	0.04%

Note: Percentages may not sum to 100 due to rounding.

Veil of Darkness Analysis with Only SCP Locations

We conducted the same VOD analysis described earlier but this time for only stops that occurred during the ITP in the SCP locations. Given this is a city-level analysis restricted to grant/directed patrol-based traffic stops, the post-level trooper data and assignment information were omitted from these analyses. We modified the violent crime data to reflect city-level crime rates to accurately account for its potential influence on the race/ethnicity of a driver in traffic stops.[7] We restricted analyses to stops involving African-American and Hispanic drivers given that our earlier analyses found disparities among these groups.

Table 7 presents the results from the VOD analysis involving only SCP locations and reveals two important findings. First, the results indicate that daylight traffic stops were 60% more likely to involve an African-American driver than stops conducted in darkness (OR = 1.60, $p \leq .01$, 95% CI[1.39,1.84]). This reveals that, again, traffic stops during periods where visibility was presumably better were more likely to involve African Americans—even after controlling for variation in stop characteristics and violent crime rate. Second, the results reveal that daylight no longer predicted the odds of a driver being Hispanic. It appears that restricting the VOD analysis to only SCP

Table 7. SCP Locations Veil of Darkness logistic regression predicting driver race

	Driver Race/Ethnicity								
	African American (N = 4,219)					Hispanic (N = 97)			
			95% CIs				95% CIs		
	OR	SE	LL	UL		OR	SE	LL	UL
Variables									
Intercept	1.91†	0.69	0.94	3.88		0.01**	0.01	0.00	0.10
Daylight	1.60**	0.11	1.39	1.84		0.66	0.17	0.40	1.10
Discretion Level [b]									
High Discretion	1.14	0.17	0.86	1.52		0.75	0.32	0.32	1.73
Uncertain	1.05	0.23	0.69	1.62		1.00	0.28	0.57	1.75
Day of Week [c]									
Monday	0.72**	0.03	0.66	0.79		1.22	0.20	0.96	1.55
Tuesday	0.64**	0.07	0.52	0.80		0.65	0.28	0.23	1.80
Wednesday	0.80	0.17	0.53	1.22		0.24**	0.06	0.15	0.39
Thursday	0.89	0.22	0.54	1.46		0.79	0.25	0.41	1.52
Friday	0.90	0.27	0.50	1.61		0.48	0.15	0.19	1.20
Saturday	0.89	0.09	0.73	1.10		0.41**	0.14	0.20	0.82
Time of Day	1.02	0.03	0.96	1.08		1.06	0.06	0.95	1.19
Male	1.28**	0.07	1.15	1.43		2.35**	0.40	1.68	3.28
Violent Crime Rate	1.00**	≤0.01	1.00	1.00		1.00	≤0.01	1.00	1.00
Model Statistics									
Pseudo R^2	0.02					0.04			

Note: OR indicate odds ratios. Robust errors clustered by city. [a] Reference assignment type is General patrol. [b] Reference discretion level is Low Discretion. [c] Reference day of week is Sunday. † $p \leq 0.10$, * $p \leq .05$, ** $p \leq .01$

[7] All crime data for the SCP analysis come from the 2020 National Incident Based Reporting System crime data explorer (https://crime-data-explorer.fr.cloud.gov/pages/explorer/crime/crime-trend).

locations reveals a greater disparity for African-American drivers and no disparity for Hispanic drivers. However, it is important to note that this finding is based on a small number of Hispanic driver stops (N = 97).

Veil of Darkness Analysis without SCP Locations

Given the potential influence that grant/directed patrol activity occurring in SCP locations may have in explaining the racial disparities observed in the main analyses, we re-estimated the VOD models while excluding those traffic stops. Accordingly, the total number of traffic stops was reduced by 10.6% to include only the 43,439 traffic stops that fall within the ITP and were not conducted in SCP locations while under grant/directed patrol assignment (i.e., we removed the SCP stops from the main analysis reported earlier).

Table A2 and A3 in the appendix present the results of these multilevel logistic regression models where daylight predicts the race/ethnicity of a driver in a traffic stop. As noted in Table A2, the results remain substantively the same. Traffic stops conducted in daylight were 14% more likely to involve African-American drivers compared to traffic stops that occurred in periods of darkness—holding constant all other variables in the model (OR = 1.14, $p \leq .05$, 95% CI[1.01, 1.29]). The main results of the VOD analysis remained the same for Hispanic drivers as well. Daylight stops were 24% more likely to involve a Hispanic driver than stops conducted during periods of darkness (OR = 1.24, $p \leq .01$, 95% CI[1.08, 1.42])—net of all other variables in the model. Lastly, all results remained nearly identical when compared to the findings in the main analysis for Asian drivers and drivers of other races/ethnicities. Accordingly, omitting traffic stops that occurred in SCP locations does not explain away the previously identified disparities identified statewide.

Post-by-Post Analyses

Post-by-Post Veil of Darkness Analyses

A key concern of the current report was to better understand the extent of racial/ethnic disparities among traffic stops conducted by MSP troopers through assessments at more local levels of analysis. The above findings demonstrated considerable variability in the extent and magnitude of racial/ethnic disparities among traffic stops across posts. Accordingly, more can be learned about the extent of these disparities by conducting the VOD analysis within each post. Therefore, in a series of analyses, we conducted post-by-post VOD analyses, whereby all stops conducted by troopers assigned in each respective post were examined separately.[8] The results from these analyses are presented in Table 8. Importantly, we restricted these analyses to stops involving African-American and Hispanic drivers because our previous models showed disparity among these groups. One important finding emerged from these analyses. The results suggest that a small number of posts drive the racial/ethnic disparities observed among all MSP stops. Daylight predicted the odds of a traffic stop involving an African-American driver in 7 of the 30 MSP posts. Six of these posts had a significantly greater odds of African-American drivers being pulled over

[8] To reach these ends, we estimated a series of single-level logistic regression equations to predict driver race for each post—holding constant all stop-level variables. Post-level variables were omitted from these models because they were estimated at the post-level to begin with (i.e., there would be no variation in such variables).

during daylight than in darkness (i.e., Lansing, Monroe, Tri-City, Flint, Lakeview, and Houghton Lake Post). Conversely, daylight stops were significantly *less* likely to involve an African-American driver in one post (i.e., Grand Rapids).

Table 8. Post-by-post Veil of Darkness logistic regression predicting driver race/ethnicity

		Driver Race/Ethnicity					
		African-American			Hispanic		
		OR	*p*	N	OR	*p*	N
District	**Post**						
District 1	11-Lansing Post	1.24†	0.09	479	0.88	0.66	65
	12-Brighton Post	1.24	0.16	327	0.82	0.65	30
	13-Jackson Post	1.20	0.34	154	1.20	0.68	20
	14-Monroe Post	1.83**	0.00	139	2.49**	0.00	63
District 2	21-Metro North Post	1.03	0.70	1,055	0.78	0.44	41
	22-Metro South Post	0.91	0.34	1,838	1.09	0.81	45
District 3	31-Tri-City Post	1.24*	0.03	1,593	0.99	0.98	100
	32-West Branch Post	0.59	0.31	13	-	-	5
	33-Caro Post	1.94	0.22	18	0.72	0.70	8
	34-Lapeer Post	0.88	0.56	136	1.68	0.21	43
	35-Flint Post	1.36**	0.00	2,023	1.85	0.18	31
District 5	51-Paw Paw Post	1.01	0.94	248	0.71	0.29	43
	52-Wayland Post	1.13	0.66	81	1.24	0.54	48
	53-Niles Post	1.09	0.46	1,029	0.83	0.49	79
	54-Marshall Post	1.15	0.91	228	1.28	0.30	105
District 6	61-Grand Rapids Post	0.74**	0.01	714	1.36†	0.10	140
	62-Hart Post	0.59	0.35	23	1.18	0.69	29
	63-Mt. Pleasant Post	2.00	0.12	36	5.65*	0.03	13
	64-Lakeview Post	2.00*	0.02	61	1.22	0.75	20
District 7	71-Cadillac Post	1.49	0.31	37	2.59*	0.04	27
	72-Houghton Lake Post	1.85†	0.09	47	1.14	0.84	18
	73-Gaylord Post	0.91	0.82	33	0.73	0.69	10
	74-Alpena Post	1.70	0.47	14	3.93	0.34	6
District 8	81-Negaunee Post	1.00	0.99	26	0.65	0.60	9
	82-Sault Ste. Marie Post	0.46	0.25	7	-	-	0
	83-St. Ignace Post	1.73	0.23	28	0.90	0.92	7
	84-Gladstone Post	1.03	0.95	19	0.94	0.95	9
	85-Iron Mountain Post	1.61	0.51	13	1.37	0.64	14
	86-Wakefield post	1.78	0.46	7	2.59	0.18	3
	87-Calumet Post	1.93	0.28	13	0.99	0.99	9

Note: OR indicate odds ratios. We report odds ratios for sake of presentation clarity. The number of traffic stops involving African-American drivers and Hispanic drivers within the ITP is denoted by N for each post, respectively.

† $p \leq 0.10$, * $p \leq .05$, ** $p \leq .01$

Daylight predicted the odds of being a Hispanic driver in 4 of the 30 MSP posts. The odds of a traffic stop involving a Hispanic driver were significantly higher during periods of daylight when compared to darkness in Monroe, Grand Rapids, Mt. Pleasant, and Cadillac. In all other posts, MSP troopers were no more likely to stop African-American or Hispanic drivers during daylight when compared to darkness. This finding suggests that for most MSP posts there is no statistically significant evidence of racial- or ethnic-based disparities according to the VOD analyses. Rather, such disparities are concentrated in a small group of posts within the agency. Yet, it is worth noting that although most posts did not exhibit statistically significant racial disparity, the daylight effect was in the direction of African-American driver disparity in 16 other posts. Small samples of traffic stops in these posts may have contributed to the lack of statistical significance.

Post-by-Post Veil of Darkness Analysis without SCP Locations

We further investigated the findings described above by conducting the VOD analysis within each MSP post while omitting traffic stops that occurred in SCP locations as part of their grant/directed patrol initiative. It is important to remember that these results have no bearing on MSP posts that do not have SCP-related traffic stops, rather they reveal what happens to the existing disparity for those posts with SCP-stops. We restricted these analyses to stops involving African-American and Hispanic drivers, again, given that our initial models predicted disparities among these groups. Table 9 presents the results of the logistic regression models for each post, where daylight predicts the race/ethnicity of a driver in a traffic stop. One important finding emerged from these results. Daylight predicted an increased odds of a traffic stop involving an African-American driver in only 4 of the 30 MSP posts. Although daylight stops were significantly more likely to involve African-American drivers than stops conducted during darkness in Monroe, Flint, Lakeview, and Houghton Lake Posts, the daylight effect was no longer significant in Lansing and Tri-City Posts. In contrast, the results indicate that daylight predicted the odds of being a Hispanic driver in the same 3 MSP posts (Monroe, Mt. Pleasant, and Cadillac Post), which should not be surprising given that none of these posts had any SCP-related traffic stops. What these results suggest is that the racial disparity found in Lansing and Tri-City Posts was constrained to SCP-related traffic stops; however, there was evidence of racial disparity for all stops that occurred in Flint Post, regardless of whether they were SCP-related.

CONCLUSION

The results from this report suggest that racial and ethnic disparities in MSP traffic stop behavior existed when we consider stops across the entire state of Michigan. However, a deeper dive into the data revealed that the disparities were constrained to a handful of MSP posts. Daylight stops were more likely to involve African-American drivers in Lansing, Monroe, Tri-City, Flint, Lakeview, and Houghton Lake Posts. Daylight stops were more likely to involve Hispanic drivers in Monroe, Grand Rapids, Mt. Pleasant, and Cadillac Posts. In the Lansing and Tri-City Posts, the African-American driver disparity was constrained to stops conducted in accordance with the Secure Cities Partnership.

Table 9. Removed SCP location stops post-by-post veil of darkness logistic regression predicting driver race/ethnicity

		Driver Race/Ethnicity					
		African-American			Hispanic		
		OR	*p*	N	OR	*p*	N
District	**Post**						
District 1	11-Lansing Post	0.97	0.85	289	1.01	0.98	53
	12-Brighton Post	1.24	0.16	327	0.82	0.65	30
	13-Jackson Post	1.20	0.34	154	1.20	0.68	20
	14-Monroe Post	1.83**	0.00	139	2.49**	0.00	63
District 2	21-Metro North Post	1.03	0.70	1,055	0.78	0.44	41
	22-Metro South Post	0.86	0.18	1,248	1.10	0.80	40
District 3	31-Tri-City Post	0.97	0.80	460	1.18	0.63	47
	32-West Branch Post	0.59	0.31	13	-		5
	33-Caro Post	1.94	0.22	18	0.72	0.70	8
	34-Lapeer Post	0.88	0.56	136	1.68	0.21	43
	35-Flint Post	1.32*	0.02	749	1.83	0.29	19
District 5	51-Paw Paw Post	1.01	0.94	248	0.71	0.29	43
	52-Wayland Post	1.13	0.66	81	1.24	0.54	48
	53-Niles Post	1.05	0.74	364	0.94	0.81	70
	54-Marshall Post	1.15	0.36	228	1.28	0.30	105
District 6	61-Grand Rapids Post	0.73*	0.03	347	1.36	0.13	134
	62-Hart Post	0.59	0.35	23	1.18	0.69	29
	63-Mt. Pleasant Post	2.00	0.12	36	5.65*	0.03	13
	64-Lakeview Post	2.00*	0.02	61	1.22	0.75	20
District 7	71-Cadillac Post	1.49	0.31	37	2.59*	0.04	27
	72-Houghton Lake Post	1.85†	0.09	47	1.14	0.84	18
	73-Gaylord Post	0.91	0.82	33	0.73	0.69	10
	74-Alpena Post	1.70	0.47	14	3.93	0.34	6
District 8	81-Negaunee Post	1.00	0.99	26	0.65	0.60	9
	82-Sault Ste. Marie Post	0.46	0.25	7	-		0
	83-St. Ignace Post	1.73	0.23	28	0.90	0.92	7
	84-Gladstone Post	1.03	0.95	19	0.94	0.95	9
	85-Iron Mountain Post	1.61	0.51	13	1.37	0.64	14
	86-Wakefield post	1.78	0.46	7	2.59	0.18	3
	87-Calumet Post	1.93	0.28	13	0.99	0.99	9

Note: OR indicate odds ratios. We report odds ratios for sake of presentation clarity. The number of traffic stops involving African-American drivers and Hispanic drivers within the ITP is denoted by N for each post, respectively.

† $p \leq 0.10$, * $p \leq .05$, ** $p \leq .01$

At this point, additional assessments are needed to know whether there are explanations for the disparities found within these posts. For example, racial disparity being constrained to SCP-

related stops in Tri-City and Lansing Posts may be explained by a variety of factors. The racial makeup of the communities where SCP stops take place, the race-based driving patterns in those locations, or the deployment strategies used by time of day, may all help explain why African-American drivers are pulled over more during daylight than during darkness in these SCP patrol locations. However, other factors would have to be used to explain the disparity in traffic stop behavior found in Flint Post, which remained significant even after omitting SCP-related traffic stops within the worksite. Moreover, there were multiple posts that never conducted SCP-related stops; thus, yet other factors may explain the disparity found in these locations. Further investigation is necessary to determine whether any legitimate factors explain the observed disparity or whether discriminatory practices may be taking place. MSP recently deployed an internal benchmark data dashboard that may be useful in examining some factors in more detail. Furthermore, an analysis that uses GPS location data for individual traffic stops may allow for a more nuanced examination of racial/ethnic disparity at a more microlevel. It is the research team's understanding that MSP will be able to provide such traffic stop data for stops that occur during 2022.

Future assessments of MSP traffic stops may also consider whether any racial disparity is concentrated among specific troopers. Preliminary evidence suggests that a large number of traffic stops were conducted by a fraction of all troopers in MSP.[9] The extent to which this generated racially disparate traffic stop behavior is largely unknown. This is due to the fact that we could not identify the demographic makeup of troopers who conducted each traffic stop. Without trooper demographics, it is impossible to account for what may be generating potential differences in traffic stop behavior across troopers. For example, it may be that the disparities exhibited within and across posts are concentrated among specific troopers, and this could be tied to differences in trooper deployment strategies, specific unit assignments, or even the race/ethnicity of troopers. Research has shown that racial disparities in traffic stop behavior can be due in part to racial differences between officers and citizens (Taniguchi et al., 2017). It will be necessary for the agency to explore these types of questions to determine whether racial disparities can be explained by factors unrelated to discrimination.

Finally, it is important to note that this report is not capable to making direct comparisons to last year's MSP racial/ethnic disparity report (see Wolfe et al., 2021). The current report did not explore trends in racial/ethnic disparity and the analyses were fundamentally different from last year's report. Namely, this year's report examined post-level racial/ethnic disparity using the VOD methodology whereas last year's report explored district-level disparities. The current report also better accounted for the level of discretion available to the trooper at the time of the stop. Last year's report was only able to account for whether traffic stops involved hazardous or non-hazardous violations. And, finally, making year-to-year comparisons is ill advised because events particular to a given year may account for divergent trends rather that changes in behavior related

[9] Approximately 66% of all traffic stops were conducted by a third of MSP troopers, and just over 25% of all stops were conducted by 5% of troopers.

to outcomes of interest. For example, COVID-19 and the civil unrest following the murder of George Floyd may have impacted driving and traffic stop behavior differently in 2020 (the focus of last year's report) than it did in 2021 (the focus of this year's report). To adequately examine trends in MSP traffic stop racial/ethnic disparity (e.g., whether racial/ethnic disparity is increasing or decreasing), numerous years of data would be required to help rule out the influence of such historical events and other idiosyncrasies within a given year.

Appendices

Table A1. Multilevel Veil of Darkness logistic regression predicting driver race/ethnicity: African American and Hispanic—30 days before and after daylight savings time began and ended

	Driver Race/Ethnicity							
	African American (N = 3,252)				Hispanic (N = 296)			
			95% CIs				95% CIs	
	OR	SE	LL	UL	OR	SE	LL	UL
Fixed Effects								
Stop-Level Variables								
Intercept	0.01**	0.01	0.00	0.06	0.01**	≤0.01	0.00	0.02
Daylight	1.08	0.15	0.82	1.42	1.37	0.27	0.92	2.03
Assignment Type [a]								
Grant/directed patrol	4.65**	1.17	2.84	7.62	0.94	0.29	0.52	1.72
Field Training program	0.62**	0.10	0.46	0.85	1.12	0.36	0.60	2.09
Sergeant's duties	1.37	0.38	0.79	2.37	1.04	0.38	0.51	2.12
Other assignment	0.90	0.24	0.53	1.53	1.77	0.75	0.77	4.07
Hometown Assignment	-	-	-	-				
Discretion Level [b]								
High Discretion	0.98	0.12	0.77	1.24	1.17	0.20	0.83	1.65
Uncertain	1.96**	0.31	1.44	2.66	0.81	0.40	0.31	2.11
Day of Week [c]								
Monday	0.83†	0.09	0.67	1.04	1.05	0.30	0.59	1.85
Tuesday	0.87	0.15	0.61	1.23	0.92	0.26	0.53	1.60
Wednesday	0.96	0.16	0.68	1.34	0.95	0.24	0.57	1.56
Thursday	0.83†	0.09	0.68	1.02	0.97	0.21	0.64	1.48
Friday	0.95	0.12	0.75	1.21	0.92	0.24	0.54	1.54
Saturday	0.89	0.14	0.66	1.20	0.77	0.19	0.48	1.24
Time of Day	1.10*	0.04	1.01	1.18	1.05	0.05	0.95	1.15
Male	1.15	0.10	0.97	1.36	2.05**	0.32	1.51	2.78
Post-Level Variables								
Violent Crime Rate	1.00**	≤0.01	1.00	1.01	1.00	≤0.01	1.00	1.00
Troopers Per Capita	0.80	0.13	0.58	1.09	0.88	0.09	0.72	1.09
Random Effects								
Post-Level Variance (τ^2_0)	1.02	0.26	0.62	1.67	0.54	0.14	0.32	0.89
Daylight Variance (τ^2_1)	0.03	0.07	0.00	4.17	-	-	-	-
Deviance	10,571.78				2,771.39			

Note: OR indicate odds ratios. Robust errors reported for stop-level variables. [a] Reference assignment type is General patrol. [b] Reference discretion level is Low Discretion. [c] Reference day of week is Sunday. † $p \leq 0.10$, * $p \leq .05$, ** $p \leq .01$

Table A2. Non-SCP locations multilevel Veil of Darkness logistic regression predicting driver race/ethnicity: African American and Hispanic

	Driver Race/Ethnicity							
	African American (N = 6,220)				Hispanic (N = 943)			
			95% CIs				95% CIs	
	OR	SE	LL	UL	OR	SE	LL	UL
Fixed Effects								
Stop-Level Variables								
Intercept	0.02**	0.01	0.00	0.06	0.01**	≤0.01	0.00	0.02
Daylight	1.14*	0.07	1.01	1.29	1.24**	0.09	1.08	1.42
Assignment Type [a]								
Grant/directed patrol	0.97	0.18	0.68	1.38	1.03	0.12	0.82	1.31
Field Training program	0.94	0.12	0.73	1.21	1.04	0.21	0.70	1.56
Sergeant's duties	1.55*	0.33	1.02	2.35	0.83	0.18	0.55	1.26
Other assignment	1.03	0.13	0.79	1.33	1.04	0.30	0.59	1.83
Hometown Assignment	-	-	-	-	-	-	-	-
Discretion Level [b]								
High Discretion	0.91	0.08	0.77	1.07	0.92	0.06	0.81	1.05
Uncertain	1.73**	0.24	1.32	2.27	0.98	0.26	0.58	1.64
Day of Week [c]								
Monday	0.87*	0.06	0.76	0.99	1.05	0.11	0.86	1.29
Tuesday	0.88†	0.07	0.76	1.02	0.99	0.12	0.78	1.26
Wednesday	0.97	0.06	0.86	1.10	0.84	0.09	0.68	1.04
Thursday	0.82**	0.06	0.70	0.95	0.94	0.09	0.78	1.14
Friday	0.94	0.07	0.81	1.08	0.81*	0.09	0.65	1.00
Saturday	1.02	0.07	0.89	1.17	0.96	0.09	0.80	1.15
Time of Day	1.06**	0.03	1.01	1.11	1.03†	0.02	1.00	1.07
Male	1.15	0.06	1.03	1.28	2.14**	0.22	1.74	2.62
Post-Level Variables								
Violent Crime Rate	1.00**	≤0.01	1.00	1.01	1.00	≤0.01	1.00	1.00
Troopers Per Capita	0.82	0.12	0.62	1.09	0.85*	0.07	0.72	0.99
Random Effects								
Post-Level Variance (τ^2_0)	0.81	0.20	0.50	1.33	0.49	0.12	0.30	0.78
Daylight Variance (τ^2_1)	0.06	0.02	0.03	0.12	-	-	-	-
Deviance	27,142.44				8,505.22			

Note: OR indicate odds ratios. Robust errors reported for stop-level variables. [a] Reference assignment type is General patrol. [b] Reference discretion level is Low Discretion. [c] Reference day of week is Sunday. † $p \leq 0.10$, * $p \leq .05$, ** $p \leq .01$

Table A3. Non-SCP locations multilevel Veil of Darkness logistic regression predicting driver race/ethnicity: Asian and Other

	Driver Race/Ethnicity							
	Asian (N = 286)				Other (N = 188)			
			95% CIs				95% CIs	
	OR	SE	LL	UL	OR	SE	LL	UL
Fixed Effects								
Stop-Level Variables								
Intercept	0.01**	≤0.01	0.00	0.01	0.00	0.00	0.00	0.00
Daylight	1.30	0.23	0.91	1.85	1.12	0.16	0.85	1.49
Assignment Type [a]								
Grant/directed patrol	0.94	0.17	0.67	1.33	0.78	0.22	0.44	1.36
Field Training program	0.78	0.26	0.40	1.51	1.13	0.46	0.50	2.52
Sergeant's duties	0.96	0.39	0.44	2.12	1.70	1.00	0.54	5.38
Other assignment	1.78	0.54	0.99	3.21	-	-	-	-
Hometown Assignment	-	-	-	-	-	-	-	-
Discretion Level [b]								
High Discretion	0.43**	0.07	0.31	0.60	0.96	0.26	0.57	1.63
Uncertain	0.08**	0.08	0.01	0.59	1.32	0.70	0.47	3.74
Day of Week [c]								
Monday	0.89	0.20	0.57	1.39	0.83	0.21	0.50	1.37
Tuesday	0.70	0.20	0.40	1.22	1.29	0.47	0.63	2.65
Wednesday	0.43**	0.12	0.25	0.74	1.06	0.35	0.56	2.04
Thursday	0.66	0.22	0.35	1.25	1.39	0.40	0.78	2.45
Friday	0.65*	0.13	0.44	0.95	0.94	0.35	0.46	1.95
Saturday	0.65†	0.15	0.41	1.01	1.12	0.41	0.54	2.30
Time of Day	1.03	0.03	0.98	1.09	1.08†	0.04	1.00	1.16
Male	1.02	0.13	0.79	1.30	1.03	0.18	0.74	1.44
Post-Level Variables								
Violent Crime Rate	1.00**	≤0.01	1.00	1.01	1.00	≤0.01	1.00	1.00
Troopers Per Capita	0.99	0.05	0.91	1.09	1.19†	0.12	0.98	1.46
Random Effects								
Post-Level Variance (τ^2_0)	0.41	0.20	0.15	1.06	1.67	0.68	0.76	3.71
Daylight Variance (τ^2_1)	0.14	0.10	0.04	0.56	-	-	-	-
Deviance	3,294.57				2,157.48			

Note: OR indicate odds ratios. Robust errors reported for stop-level variables. [a] Reference assignment type is General patrol. [b] Reference discretion level is Low Discretion. [c] Reference day of week is Sunday. † $p \leq 0.10$, * $p \leq .05$, ** $p \leq .01$

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